

CLAIMS

1. A data processing apparatus operable to form a reduced-bandwidth-version of an original material item, the reduced-bandwidth-version including a code word from a predetermined set of code words, and an impaired version of the material item from which a marked representation of the original material item can be formed, wherein the impaired version is formed by removing the reduced-bandwidth-version of the material item from a copy of the original material item.
2. A data processing apparatus as claimed in Claim 1, comprising a first bandwidth processor operable to form the reduced-bandwidth-version of the original material item, the bandwidth reduction occurring in at least one of the temporal or spatial domains, an encoding processor operable to form the marked reduced-bandwidth-version of the original material item by combining the code word with the reduced-bandwidth-version of the original material item, and a material adaptation processor operable to form an impaired version of the original material item by subtracting the reduced-bandwidth-version of the material item from the original material item.
3. A data processing apparatus as claimed in Claim 2, comprising a second adaptation processor operable to up-convert the reduced-bandwidth-version of the original material item in accordance with the bandwidth reduction performed by the first bandwidth adaptation processor, the bandwidth of the up-converted reduced bandwidth version corresponding to that of the original material item, and the material adaptation processor is operable to subtract the up-converted reduced-bandwidth-version from the copy of the original material item.
4. A data processing apparatus as claimed in Claim 2, comprising a data storage means operable to store the marked reduced-bandwidth-version and the impaired version of the material item individually.

5. A data processing apparatus as claimed in Claim 4, wherein a plurality of encrypted marked reduced-bandwidth-versions of the material item are stored with the impaired material item on a storage medium.

5 6. A data processing apparatus as claimed in Claim 3, wherein the marked reduced-bandwidth-version and the impaired version of the material item are stored on separate media.

10 7. A data processing apparatus as claimed in Claim 1, comprising a data communications apparatus operable to communicate the marked reduced-bandwidth-version and the impaired version of the material item separately.

15 8. A data processing apparatus as claimed in Claim 7, wherein the impaired version of the material item is transmitted via a data communications network, and the reduced-bandwidth-version is distributed via a data carrier.

9. A data processing apparatus as claimed in Claim 7, wherein the impaired version of the material item is distributed via a data carrier, and the reduced-bandwidth-version is transmitted via a data communications network.

20 10. A data processing apparatus as claimed in Claim 2, wherein the encoding processor is operable to adapt coefficients of the code word with respect to the samples of the reduced-bandwidth-version of the material item to which the code word coefficients are to be combined, wherein the adaptation of the code word coefficients with respect to the reduced-bandwidth-version is made to the effect of reducing a likelihood of detection of the code word in the marked representation of the material item.

30 11. A data processing apparatus as claimed in Claim 2, wherein the bandwidth reduction processor comprises

a temporal sub-sampler operable to form the reduced-bandwidth-version of the material item in the time domain.

12. A data processing apparatus as claimed in Claim 11, wherein the temporal sub-sampler comprises a low-pass filter in combination with a sample selector operable to selectively sample the material item after low-pass filtering.

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13. A data processing apparatus as claimed in Claim 1, wherein the bandwidth reduction processor comprises  
a spatial sub-sampler operable to form the reduced-bandwidth-version of the material item.

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14. A data processing apparatus as claimed in Claim 13, wherein the spatial sub-sampler comprises a low pass filter and a sample selector operable to select predetermined samples with respect to a spatial reference after low pass filtering.

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15. A data processing apparatus as claimed in Claim 14, wherein the sample selector comprises a wavelet transform processor operable to form a wavelet transform of the material item and to select one of a plurality of sub-bands of the wavelet transform to form the reduced-bandwidth-version of the material after low pass filtering, the wavelet transform sub-bands providing the spatial reference

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16. A data processing apparatus as claimed in Claim 2, wherein the encoding processor comprises a code word generator operable to generate the code word using a pseudo-random number generator initialised with a seed value uniquely associated with the code word, the code word coefficients being formed from numbers generated by the pseudo-random number generator.

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17. A data processing apparatus as claimed in Claim 16, wherein the encoding processor comprises

a discrete cosine transform processor operable to transform the reduced-bandwidth-version of the material item into the discrete cosine transform domain, the reduced-bandwidth-version of the material item in the discrete cosine transform domain being represented as a plurality of discrete cosine transform coefficients,

wherein the encoding processor is operable to combine the code word with the material item by adding each of the code word coefficients to a corresponding one of the discrete cosine transform coefficients, and

5 an inverse discrete cosine transform processor operable to form the marked reduced-bandwidth-version of the material item by performing an inverse discrete cosine transform on the discrete cosine transformed reduced-bandwidth-version to which the code word has been added by the encoding processor.

18. A reproducing apparatus for reproducing a representation of an original material item from a reduced-bandwidth-version of the material item marked with a code word from a predetermined set of code words and an impaired version of the material item, from which a marked representation of the original material item can be formed, the apparatus comprising

15 a receiver operable to receive the impaired version of the material item, and to receive the marked reduced-bandwidth-version of the original material item, and  
a combiner operable to combine the marked reduced-bandwidth-version of the material item with the impaired version to reproduce a representation of the original material item.

20 19. A cinema projector including a reproducing apparatus according to Claim 18, wherein the material is at least one of audio signals and image signals, said projector including a projection processor operable to project the representation of the original material item reproduced by the reproducing apparatus.

25 20. A web server operable to provide material items for downloading via the Internet, the web server including a reproducing apparatus according to Claim 18, wherein the reproducing apparatus is operable to combine the marked reduced-bandwidth-version of the material item with the impaired version before the material items are downloaded.

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21. A web server including a data processing apparatus as claimed in Claim 1, operable to form an impaired version of a material item formed by subtracting a

reduced-bandwidth-version from the material item, the web server being arranged to provide access to the impaired version via the Internet, Intranet, Extranet or Private IP network and to provide the reduced-bandwidth-version of the material item marked with a code word which identifies a version of the material item formed by combining  
5 the impaired material item with the marked-reduced-bandwidth version of the material item.

22. A display device including a reproducing apparatus according to Claim 18, wherein the material is at least one of audio signals and image signals, the display  
10 device being operable to display the representation of the original material item reproduced by the reproducing apparatus on the display screen.

23. A distribution system including a data processing apparatus as claimed in Claim 1 operable to form an impaired version of a material item formed by  
15 subtracting a reduced-bandwidth-version of the material item from the original material item; the distribution system being arranged to provide access to the impaired version and to distribute to users on demand the reduced-bandwidth-version of the material item marked with a code word which identifies a version of the material item distributed to each user, the code word being arranged to identify the version of  
20 material item formed by combining the impaired material item with the marked-reduced-bandwidth version of the material item.

24. A detecting data processing apparatus operable to determine whether one or more code words of a predetermined set of code words is present in a suspected  
25 marked version of a material item, the suspected version having been assumed to have been formed by combining each of a plurality of samples of a reduced-bandwidth-version of the original material item with one of a corresponding plurality of code word coefficients, said apparatus comprising

a bandwidth processor operable  
30 to form a reduced-bandwidth-version of a copy of the original material item and a reduced-bandwidth-version of the suspected version of the material, or a reduced-bandwidth-version of a difference between the original and suspect material

items, the bandwidth reduction being arranged to isolate the part of the bandwidth of the material to which the code word may have been combined,

5        a recovery processor operable to generate a recovered code word by comparing corresponding samples of the marked-reduced-bandwidth material item with the samples of the copy of the material item,

      a correlation processor operable to generate, for each of the code words in the predetermined set of code words a correlation value by correlating the recovered code word with each of the generated code words, and

10      a detection processor operable to detect one or more code words from the correlation value for the code word exceeding a predetermined threshold.

15      25. A detecting data processing apparatus as claimed in Claim 24, wherein the correlation processor includes a code word generator operable to generate pseudo-random numbers from which said regenerated code word coefficients are formed, the pseudo-random numbers being generated from a seed value uniquely associated with said code word.

20      26. A detecting data processing apparatus as claimed in Claim 25, wherein the seed value is formed from the samples of the marked material item.

25      27. A detecting data processing apparatus as claimed in Claim 24, wherein the code word has been introduced into the reduced-bandwidth-version of the material item in the discrete cosine transform domain, the apparatus comprising

      a discrete cosine transform processor operable to transform the suspected reduced-bandwidth-version of the material item and the reduced-bandwidth-copy of the original material item into the discrete cosine transform domain, wherein the recovery processor is operable to generate the recovered code word by subtracting corresponding discrete cosine transform coefficients of the original material version from discrete cosine transform coefficients of the marked material version.

30      28. A system for identifying the recipient of a material item, the system comprising

a data processing apparatus according to Claim 1,  
a reproducing apparatus according to Claim 18, and  
a detecting data processor according to Claim 24, operable to detect with a  
predetermined false positive probability the recipient by detecting the presence or  
5 absence of the code word in the material.

29. A method of processing an original material item, comprising  
forming a reduced-bandwidth-version of the material item marked with a code  
word from a predetermined set of code words, and  
10 forming an impaired version of the material item from which a marked  
representation of the original material item can be formed.

30. A method of processing as claimed in Claim 29, wherein the forming a  
reduced-bandwidth-version of an original material item, comprises forming the  
15 bandwidth reduction in at least one of temporal or spatial domains, and  
combining the code word with the reduced-bandwidth-version of the original  
material item, and the forming the impaired version of the original material item  
comprises  
subtracting the reduced-bandwidth-version of the material item from the  
20 original material item.

31. A method of determining whether one or more code words of a  
predetermined set of code words is present in a suspected marked version of a material  
item, the suspected version having been assumed to have been formed by combining  
25 each of a plurality of samples of a reduced-bandwidth-version of the original material  
item with one of a corresponding plurality of coefficients of the code word, the method  
comprising  
forming a reduced-bandwidth-version of a copy of the original material item  
and a reduced-bandwidth-version of the suspected version of the material, or a  
30 reduced-bandwidth-version of a difference between the original and suspect material  
items, the bandwidth reduction being arranged to isolate the part of the bandwidth of  
the material to which the code word may have been combined,

generating a recovered code word by comparing corresponding samples of the marked-reduced-bandwidth material item with the samples of the copy of the material item, and

5 generating, for each of the code words in the predetermined set of code words a correlation value by correlating the recovered code word with each of the generated code words, and

detecting one or more code words from the correlation value for the code word exceeding a predetermined threshold.

10 32. A data signal representing an impaired material item or a reduced-bandwidth-version of the material item to which a code word has been embedded, as produced by the data processing apparatus according to Claim 1.

15 33. A data carrier having recorded thereon a data signal according to Claim 32.

34. A computer program providing computer executable instructions, which when loaded onto a data processor configures the data processor to operate as a data processing apparatus according to Claim 1.

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35. A computer program providing computer executable instructions, which when loaded onto a data processor configures the data processor to operate as a detecting data processor according to Claim 24.

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36. A computer program providing computer executable instructions, which when loaded on to a data processor causes the data processor to perform the method according to Claim 29.

30 37. A computer program product having a computer readable medium having recorded thereon information signals representative of the computer program claimed in Claim 34.

38. A computer program product having a computer readable medium having recorded thereon information signals representative of the computer program claimed in Claim 35.

5 39. A computer program product having a computer readable medium having recorded thereon information signals representative of the computer program claimed in Claim 36.

10 40. A data carrier bearing an impaired material item and a plurality of a reduced-bandwidth-versions of the material item to which watermark code words have been added, as produced by the data processing apparatus according to Claim 1, wherein the marked reduced-bandwidth-versions are encrypted.

15 41. An apparatus for processing an original material item, comprising means for forming a reduced-bandwidth-version of the material item marked with a code word from a predetermined set of code words, and means for forming an impaired version of the material item from which a marked representation of the original material item can be formed.

20 42. An apparatus for processing as claimed in Claim 41, wherein the means for forming a reduced-bandwidth-version of an original material item, comprises means for forming the bandwidth reduction in at least one of temporal or spatial domains, and

25 means for combining the code word with the reduced-bandwidth-version of the original material item, and the means for forming the impaired version of the original material item comprises

means for subtracting the reduced-bandwidth-version of the material item from the original material item.

30 43. An apparatus for determining whether one or more code words of a predetermined set of code words is present in a suspected marked version of a material item, the suspected version having been assumed to have been formed by combining

each of a plurality of samples of a reduced-bandwidth-version of the original material item with one of a corresponding plurality of coefficients of the code word, the apparatus comprising

- means for forming a reduced-bandwidth-version of a copy of the original material item and a reduced-bandwidth-version of the suspected version of the material, or a reduced-bandwidth-version of a difference between the original and suspect material items, the bandwidth reduction being arranged to isolate the part of the bandwidth of the material to which the code word may have been combined,
- means for generating a recovered code word by comparing corresponding samples of the marked-reduced-bandwidth material item with the samples of the copy of the material item, and
- means for generating, for each of the code words in the predetermined set of code words a correlation value by correlating the recovered code word with each of the generated code words, and
- 15 means for detecting one or more code words from the correlation value for the code word exceeding a predetermined threshold.